Nate Hagens (00:00:02):

You are listening to The Great Simplification with Nate Hagens, that's me. On this show, we try to explore and simplify what's happening with energy, the economy, the environment, and our society. Together with scientists, experts, and leaders, this show is about understanding the bird's eye view of how everything fits together, where we go from here, and what we can do about it as a society and as individuals.

(00:00:33):

Today's podcast is with Gareth Roberts. Gareth is an entrepreneur and a successful founder and former CEO of a large public oil and gas company. Gareth studied geology at Oxford University, before going on to work for Texaco and Murphy Oil in the US and United Kingdom. In the 1980s, he founded Denbury Resources, which eventually grew into a $10 billion company. Gareth stepped down from Denbury 10 years ago and has been involved in the creation of various businesses, including ones involved in carbon sequestration, helium exploration, and tertiary extraction of oil. In this conversation, Gareth and I discuss the importance of energy, humor, and science. Please welcome my longtime friend, geologist, Gareth Roberts.

(00:01:39):

Hello, Gareth. Welcome.

Gareth Roberts (00:01:40):

Hello.

Nate Hagens (00:01:42):

Great to see you, sir.

Gareth Roberts (00:01:43):

All right.

Nate Hagens (00:01:44):

I think the last time I saw you in person was when you asked me to speak when you were CEO of Denbury Resources. And I made a slide and referred to you as King of the Dung Beatles, and I can't even remember why I did that.

Gareth Roberts (00:02:01):

Yeah, probably because this was our symbol at the time.

Nate Hagens (00:02:05):

Oh, right.

Gareth Roberts (00:02:08):

The Scarab beetle is an Egyptian symbol, was a religious symbol, because they thought it was the giver of life. Because dung beetles would spring spontaneously out of dung. And they also believed that a giant dung beetle rolled the sun across the sky every day. We used it because our company at the time was basically being more efficient on the use of extraction of oil, we're using carbon oxide. And so the dung beetle was an appropriate symbol for what we're doing. And it still is a good symbol for what the world should be doing, because we need to be efficient. Elephant dung is not a waste. It might be a waste product to an elephant, but it isn't to a dung beetle, and that's the attitude we need to take to our resources.

Nate Hagens (00:03:01):

I have a ton of questions for you, Gareth. Maybe you could just start out with a couple minutes of your background. How did you arrive at this place?

Gareth Roberts (00:03:10):

Well, I was always interested in geology, geography, geomorphology as a kid. And then I got a chance to go to Oxford to study geology. And then, 1970s, I got to work for an oil company for quite a few years. And then I started my own company, which started out being a conventional oil company, but doing dung beetle type things. But then got into carbon dioxide by pure chance, really. And we ended up building a very large company that built a lot of CO2 pipelines in the Gulf Coast region of the US. And then as luck would have it, it became very useful to then take anthropogenic CO2 into that system. I left Denbury about 12 years ago now to actually try to do carbon sequestration actually in the North Sea. We put a company together to plan a very large clean coal plant and sequester the CO2 in a North Sea oil field.

(00:04:13):

At the time, the British government was still undecided really what was going on with energy, and has made a lot of poor decisions that I'm sure they regret now. But they would've liked to have the clean coal plant right now generating power. But we were just ahead of our time. Since then, more governments around the world, and now importantly, more corporations have gotten behind the idea of carbon capture. So now it's become more of a mainstream issue, and that's what I'm working on at the moment. I'm not particularly using my geological background at the moment, I'm just using more of a general professional background.

Nate Hagens (00:04:52):

Well, we're going to get into the energy and situation with oil and coal, et cetera. But you mentioned that you're a geologist. And I'm just wondering, in the conversations you and I have had over the years, what's the difference between using geological long-term thinking versus our current short-term election cycle, news cycle, political timelines?

Gareth Roberts (00:05:20):

Well, it's hugely different. I think in terms of a few thousand years of civilization, and what are we going to be like in another couple thousand years? And from a geological point of view, those are just blink of an eye. People have a hard time understanding time, but also scale. The scale of the universe and so on, it's very difficult. I often use phrases that people don't relate to because I'm thinking of a completely different timeframe, but I really do think we need to think longer term. A lot of the politics of today are talking about 2030 or 2050, but are humans planning to be around in 1,000 years, 10,000 years? We need to have a look and see when were we thinking about those timeframes, rather than overreacting to things that are happening today. And we need to understand probably a lot more about the way that the earth functions, which it does over a longer period of time.

(00:06:20):

And things happen on the earth, natural things happen that are a threat to humans. A lot of which we've not seen yet, but will happen if we're around long enough. And we have a basic problem communicating, not just as geologists, but as scientists. For example, we would often, if we're just talking socially, we'd say glacial, meaning something that happens very slowly. But in geological terms, glacial is one of the fastest processes that we have. It just can be confusing. I think we do need to start having a longer term viewpoint of the world, as well as just a short-term one.

(00:07:00):

And that's really what we wanted to talk about today was, what is the role of all of these components? And particularly with my background, I know a lot about fossil fuels. And I particularly wanted to make the point that, all right, we can't just stop using fossil fuels. They've been an enormous benefit to humanity to this point. And I know, Nate, that you have spent a lot of time trying to educate people on how fossil fuels have gotten us to this point. And it is shocking really how little people who've been around for 30 years know about energy and where it comes from.

Nate Hagens (00:07:40):

Just one comment there on your geology background. When I was in college, they called geology rocks for jocks. It was a class that people would take that wasn't that difficult or important, at least the intro one. And now 30 years later I look back, I'm like, oh dang, I wish I would've taken that. I never took a class in geology. But I wonder if taking geology, just the fact that you would take a college course in geology, allows you to imagine deep time backwards and forwards better than someone who didn't take it. Does it prime you a little bit to look at the world differently?

Gareth Roberts (00:08:17):

Oh, I'm sure it does indeed. And we looked at geology as the king of the scientists because it uses the other sciences just like little play things. We use a little bit of chemistry here, a little bit of physics over there. And of course, the paleontology uses biology. So we use the other sciences. And yes, it does give a great insight into what can happen. So much of human history is tied in with geology and how the earth is shaped. And even down to the quality of the wine that you drink, it's based on the terroir.

Nate Hagens (00:08:53):

The terroir. What's that?

Gareth Roberts (00:08:55):

Terroir, that's the French word for the soil that the vine is grown in, and it affects the quality of the wine. It's not going to affect people like us, Nate. We will drink anything.

Nate Hagens (00:09:10):

No, actually, I don't know if you Peter Ward, he's a paleo biologist. He was a former guest on this show, and he's actually writing a book about all the different wines in the world based on the rocks that are underneath the soil, and what inferences that has.

Gareth Roberts (00:09:30):

Oh, right.

Nate Hagens (00:09:30):

Yeah.

Gareth Roberts (00:09:30):

Well, one of my professors was into that as well. I guess it's one of the perks of the job.

Nate Hagens (00:09:35):

Okay. Getting back to your other comment, you and I met, you were a supporter of the oil drum way back in the day. And ironically, there was a lot of buzz, 2005, '06, '07, '08, about energy, about energy's role in society, about the critical importance of oil. And now here we are 15 years later, the situation is way worse, and it seems like people are less concerned about energy. Not withstanding the Ukraine, Russia influence on Europe and the world prices of natural gas. But it seems like we are less concerned or aware of the critical role of energy. What do you think about that?

Gareth Roberts (00:10:22):

Well, I think you're right. I think that's true. You call energy blindness in your talks, and it seems to be getting worse, not better. Well, I call it energy ignorance. And the problem with ignorance is they can lead to unscrupulous salesman and other people taking fully advantage of the ignorance. It's a very dangerous situation. I think we had more of a traction in 2007 because the price of oil was going up so much, and the price of oil then is much higher in real terms than it is at the moment. It went up to $140 a barrel in 2008. And so it was something on everybody's mind, and the idea that we might run out of oil. So in the 1950s, a guy called M. King Hubbert, who is a geophysicist, came up with a depletion curve for oil and gas provinces, in particular the United States, which went through a rapid increase in production and then gradually peaked in the 1960s and then declined.

(00:11:31):

And then a gentleman by name Colin Campbell took that up again in the 19, probably 80s. He worked extensively around the world and looked at many overlapping geological provinces, put together a global version of that. And realized that conventional oil was depleting, and was going to start declining. He actually described it as an uncomfortable plateau, which I think is what we're in at the moment. But I must point out the difference between conventional oil and non-conventional oil, because the idea of peak oil only applied to conventional oil. And if you imagine a resource like copper, and you imagine a triangle with a point at the top, there's a very small number of deposits of pure copper. But as you go down the triangle, you get more and more deposits, but they become less concentrated. So eventually you've got a lot of copper in seawater, very dilute.

(00:12:31):

The opposite occurs with conventional oil, because conventional oil is not a mineral deposit as such, it is oil that is seeped out of source rocks. Source rocks follow the regular convention, but the conventional oils then migrate into reservoirs where they can be quickly extracted. It's a different type of geology. What we've seen in the last few years is this uptick in what we call shale oil, which is a non-conventional resource. And shale oil is effectively the source rocks. Shale oil will follow a typical resource triangle. There'll be some very good source rocks in small quantities, and there'll be a lot of very poor ones. And that's what we're seeing, we're only seeing really the very best. And furthermore, they're not particularly economic, not like conventional. Let me explain that too, and I'm going to use some of your terminology, Nate, because you talk about energy return on energy invested.

(00:13:27):

And when you look at conventional oil, and imagine a well drilled in the middle of the Saudi desert in the 1950s. For the energy that you put into drilling that well, you would get thousands of units of energy back. Thousands. And then if you drilled the well in the 1970s in the US, you might get 100 units back. But I've looked very closely with some of my friends at some of their work in the shale play in West Texas, the Permian Basin, which is the daddy of the oil shales, of course. We find that we are probably looking at about two energy units for an energy unit put in, and that's very low. And probably the only reason why shale had such dynamic growth in the last 10 years is because a very, very cheap monetary policy. It was a bit of a bubble.

(00:14:23):

But the other thing to consider when we think about, say the peak oil situation, and we are running about 100 million barrels a day of oil in the world at the moment, is that net oil. And what I mean by that is, if say shale oil is now 6 million barrels of oil per day in the US, and we've really had to take one unit of energy to get two units out, our net energy is only 3 million barrels a day. So if you try to think of the net useful energy to society, we are past peak oil even with the non-conventional added.

Nate Hagens (00:15:01):

Yes, but if that were the case, it could be that we are using lower quality energy that is more abundant in order to get the higher quality oil, which underpins and acts as the hemoglobin for global commerce. Because a lot of the energy inputs are natural gas and electricity and other things. We're not just using oil to get oil.

Gareth Roberts (00:15:28):

Well, actually, the biggest component in shale-

Nate Hagens (00:15:30):

Is diesel, which does come from oil.

Gareth Roberts (00:15:32):

And it's very valuable, and in short supply at the moment. And the way I did that calculation was I used dollars. And it's very difficult using dollars because prices are up and down on both sides. But I did some analysis with some friends of mine and came up with what we think was a fairly normalized relationship, and they get about $2 back for every dollar put in. So if we assume all the energy components that go into that are equivalent to dollars in that situation, that should be roughly where we're at. But the other thing that I must point out is if you start thinking in terms of net energy out, you got to look at all the other sources that we're using today as well. And there, your question about the quality is that sometimes we're using a better quality energy that's going in than the energy that we're getting out.

Nate Hagens (00:16:21):

Right. Well, if it's electricity and diesel, that would be the case. So here's an interesting angle on this is two things. First of all, you mentioned that we used finance to enable the what is in retrospect a shale bubble. Really, we used finance to change the shape of the eventual oil pyramid or oil curve, because we increased it at the cost of an eventual steeper decline. What would you say about that?

Gareth Roberts (00:16:55):

Yeah. Yes, I think it's-

Nate Hagens (00:16:57):

Actually, here's another way to think about that, that I just thought about. Sorry to interrupt you, Gareth. You say that we're at roughly three to one EROI, so it's a net energy of two?

Gareth Roberts (00:17:08):

No, no, no. It's a net energy of one.

Nate Hagens (00:17:11):

So it's a two to one EROI, and net energy of one. Why would we do that? Here's why. Because the gross energy that we're getting, and all the jobs of the drillers and the rigs and the equipment, all of that adds to GDP. So we're growing our GDP by spending energy on getting energy. And if GDP is our cultural goal, this is all good for GDP, meanwhile we're eating our seed corn.

Gareth Roberts (00:17:39):

It's still economic in terms. If it's two to one, it's still giving these guys probably about a 20% return. It's just the problem is it's a treadmill, it goes very quickly. They make 20% on their money one year, but they've got to turn around and do it again and do it again and do it again. And any hiccup in oil and gas operations, a dry hole or a problem with a location, can throw you off. And the guys I talk to are probably the best in the business at keeping the cost down. I would imagine all the other operators are probably seeing less economics than that.

Nate Hagens (00:18:18):

The Permian is still increasing. A lot of our shale plays are in decline now, but the Permian is still growing. But how do you relate this to your copper example where we started out with pure copper and at the bottom of the pyramid it's tiny molecules of copper diluted in seawater? How is that in the shale example?

Gareth Roberts (00:18:40):

Shales are very complex rock types. They're not really shales. These are hybrid silt stones, that have a high carbonation content, and we don't really understand how the oil gets out of there. All right? Is trial and error is what you're seeing out there. What you have, is we don't know where the peak of the pyramid is, we're still looking for it. And in some cases we're finding the sweet spots, but a lot of the drilling that has gone on has not been in the sweet spots, or has been in shale plays that don't work. It's just a little bit more complicated geologically.

(00:19:19):

Now natural gas is a slightly different thing because it's some smaller molecule. These type of shale rocks that we're talking about, which it's difficult to get oil out of them, it's easier to get natural gas out of them. Natural gas has got more of a future now than oil does. And natural gas is going to be a vital component of energy in the next few years globally, so it needs to become a global commodity. More and more LNG facilities need to be built. And we do have some stranded conventional reserves of natural gas that can be utilized. And the question is, how can we utilize that quickly, and what's the best way to utilize it?

Nate Hagens (00:20:02):

Okay. I'm going to fire some possibly naive questions at you that are popping into my head. How much natural gas production in the United States comes as a byproduct of oil drilling, and how much oil comes as a byproduct of natural gas drilling?

Gareth Roberts (00:20:21):

Well, quite a lot. In the case of the Permian Basin, although their largest product is oil, close behind it is natural gas. Because these are actually reservoirs that are almost natural gas reservoirs, that's why they're able to produce this oil. If it was just oil in there, it would never come out. What you see is, as time goes by which these wells are produced longer, they produce more gas relative to oil. So it's a

significant portion. I don't know the exact number, but it's probably 30 or 40% of the hydrocarbons that come out of a Permian well are natural gas.

Nate Hagens (00:21:02):

Right. What's happened at the evolution of technology in fracking? Is it getting better and better every year, or is it just that the prices have made it more economic? And then a sub-question of that, the same amount of oil that was ultimately recoverable is largely the same. So fracking hasn't created more oil, it's just acted as a larger straw to the milkshake, as it were.

Gareth Roberts (00:21:31):

Well, fracking in the oil prone areas, the oil recovery is very low. In a traditional conventional reservoir, sandstone porous reservoir, you could be getting out 50%, even with carbon dioxide, we were getting up to 70% of the oil out. But in a non-conventional shale silt stone, you are only getting five to 10% of it out.

Nate Hagens (00:21:54):

What happens to the rest of the oil, just sits there?

Gareth Roberts (00:21:56):

Stays in the rock, and you can't get it out.

Nate Hagens (00:22:02):

And could we use CO2 or tertiary recovery to get more out of the shale?

Gareth Roberts (00:22:06):

Yes, you could. Yes, you could. You could use tertiary. We don't know yet at the moment, it's one of my projects back there in the file. Yeah, you could do it. That's not been tried yet. Obviously, using CO2 to get more oil out of an existing well means you don't have to drill a new well, you're already at a brownfield site.

Nate Hagens (00:22:25):

What's a brownfield site?

Gareth Roberts (00:22:27):

One that's already been industrialized. A greenfield site is a nice greenfield where you decide to drill a well. A brownfield site is where you've already got industrial activity, oil wells or refinery, whatever. And so it makes sense to utilize brownfield sites first if you can.

Nate Hagens (00:22:46):

I saw an aerial view last week of Midland, Texas. It seems like they're surrounded by brownfield sites.

Gareth Roberts (00:22:53):

Well, yeah, the whole countryside is brown. Probably because it's partly desert. They have a couple of trees in Midland. They keep them so the kids can see them.

Nate Hagens (00:23:03):

Getting back to the core question here, how do you now, putting together conventional oil, unconventional oil, how do you see the United States and global peak oil story circa 2022?

Gareth Roberts (00:23:20):

Well, the problem we have at the moment is there's not a lot of reinvestment going into it. So it's clearly going to decline. And because of the factors I mentioned, the net oil that we get, the surplus oil that we get and we can use is going to be less. But oil is not going to be around forever and ever, it's a finite resource, as is natural gas. Although I said there's a bit more of that kicking around. What's going to happen in 100 years? What's going to happen in 1,000 years? Now, the thing that's valuable about oil is this carbon bond that's in it. And from that we manufacture so many useful products. Even today we do. But in the future, this oil is going to be so valuable for those specialist chemicals that allow humans to have the lives that we lead, that it's really tragic that we just burn it today for heat.

(00:24:19):

In 100 years, or possibly 1,000 years, they will look back on our generation as some of the most profligate people that have ever lived. And not only that, we're completely inefficient as well just on top of that. But we are just burning the stuff up. I say it's like burning antique furniture for firewood. We shouldn't do it, but we've got to this point. And so I think we're all in agreement that we want to use less. I'm saying that not because there's something really evil about it, it's just that we need to preserve a resource sensibly for the next 10 generations or so. That's my position on long-term oil.

Nate Hagens (00:25:04):

Okay. Well, let me ask you a follow-up to that, and then I'll get back to the peak oil question. You are among many people that have studied and worked in geology that have said something similar to me, that potentially the best use of fossil hydrocarbons isn't the burning and ignition, but the chemical compounds. Can you just give a one-minute example of some of the key things that we get from hydrocarbons?

Gareth Roberts (00:25:34):

Well, fertilizers. Fertilizers are created by the Haber-Bosch process, which is from natural gas, but it's fixing the nitrogen in the air. And something like 60% of the nitrogen in our bodies has been fixed by the Haber-Bosch process. We wouldn't be able to have this many people on the planet without that extra nitrogen being fixed into protein. The definition I saw the other day on a course, the definition of modern agriculture is the conversion of fossil fuels into food, that's how they define it. Food production is at the moment critical for fossil fuels, but then all of the clothes that we wear, the materials that we

build cars with, the houses and the materials that we have. It's astonishing. Cosmetics for the ladies, that all comes from petrochemicals.

Nate Hagens (00:26:30):

People don't know you as well as I do. They don't know that you were trying to make a joke there.

Gareth Roberts (00:26:34):

I was almost about to make a joke, but I held myself back. I'm getting older and wiser now.

Nate Hagens (00:26:42):

Here's the thing, and I don't know if you watched a recent episode I had with Art Berman. But one of the things that I think is just totally missing from our discourse is, oh, we want to have electric cars so that we don't need oil anymore. Well, technically we wouldn't need gasoline even if that was possible. But if we didn't need gasoline, we would still need the same amount of oil for all these other products that society completely depends on.

Gareth Roberts (00:27:10):

Yeah, it's something like 40% of all hydrocarbons going to something else, they're not all burnt. And it's been growing. As more and more products get made from it, it's growing. You can't call for the complete elimination of fossil fuels sensibly. I think you can't do that. But let's just talk about how a transition's going to work then. If we accept that fossil fuels play a very important part of life today, how are we going to transition out of that? That's the problem.

Nate Hagens (00:27:47):

Let me put a pin in that and get back to my other question. Of course, there's lots of variables that come into play. There's geopolitics, there's debt and finance, there's other things. But middle of the curve, what will be our oil production as a global culture 10 years from now, 30 years from now, based on underlying decline rates and lower EROI as you were saying? Do you have any ideas?

Gareth Roberts (00:28:17):

Well, I think that the price of oil is going to go up several fold at some point. The reason for saying that is because the amount of energy that's in a barrel of oil is so valuable that the current prices have got nothing to do with its utility. I think you've calculated the number of man-hours that go into a barrel of oil, and I can't remember what it is. Do you remember? It's several hundred.

Nate Hagens (00:28:43):

It's 11 years of physical labor would match the BTUs in a barrel of oil. But humans are more efficient when they exert their muscles towards a task. So if you account for that efficiency, it ends up being four and a half years of human labor to equal one barrel of oil.

Gareth Roberts (00:29:01):

As long as oil is available, it will be utilized because of that fact. And we could stand that to be a lot more expensive in terms of dollars or another currency.

Nate Hagens (00:29:13):

At $1,000 a barrel it's a fricking bargain.

Gareth Roberts (00:29:14):

Absolutely it is. I expect the price of oil will go up. And when the price of oil goes up, then it means that even some of this very marginally economic energy return on energy investments, it's still a positive return. I think the world will find ways to get out what it needs. But I think without a step change in the price of oil, it will decline. I think the net energy available to us will gradually go down. And this poses a real problem, particularly in developing nations, which absolutely need that oil. There is no substitute, they don't have an electrical grid. There almost needs to be some understanding that we need to make sure that these developing countries get some fossil fuels, which is the opposite of the current thinking. But if you look at the current crisis in Europe, what's happened is Germany bought up all the LNG cargos that are going. And places like Pakistan and Bangladesh, although they don't use very much, they got none at all. So it's a bit of a problem.

Nate Hagens (00:30:30):

And it's going to get to be a much bigger problem, I fear.

Gareth Roberts (00:30:33):

It is.

Nate Hagens (00:30:34):

Because oil at $400 a barrel, wealthy nations would struggle, but they would be able to manage that with some rationing and other things, that would just destroy some of the global south if they either had to pay that or couldn't access it at all.

Gareth Roberts (00:30:50):

What we've been talking about with energy blindness, is this blindness to the idea that these fossil fuels are very precious and they need to be dolled out to everybody that needs them. It can't just be shut off, it's more critical than that.

Nate Hagens (00:31:08):

Two scenarios, I know which one that I'm expecting. But based on what you said, is as oil prices go up, that will crush economies. But it'll also, if it's stays up, it will give a signal to oil companies that it's okay to drill because we will get paid back instead of 2020 when oil was negative $37 in the futures market for a few hours. So we could continue to grow the gross energy that we extract, even at the same time

that the net energy declines. And it's just the maw of the global superorganism that we end up spending 15 or 20% or even more of our total energy on energy. Meanwhile, that still is producing GDP. You're saying that that's possible. The alternative thing is that it crashes the financial claims that require energy to pay them back, and we have a much smaller economy and less complexity, which is what I'm expecting. But what do you think about that?

Gareth Roberts (00:32:16):

I think that the total amount of oil, the gross oil, I don't see that going up much at all. And the net oil will trickle downwards as the energy sources become more expensive to exploit. I just think the world is going to have to use less. Inevitably it's going to be less. And I think we've got to be massively more efficient in the way we use energy. We're extremely wasteful at the moment, so I don't see that as a real problem.

Nate Hagens (00:32:43):

But if we become massively more efficient in today's culture that has GDP as a cultural goal and financial profits as an objective, that efficiency the gains from new efficiency will just be funneled back into that model. Right?

Gareth Roberts (00:32:59):

Well, yeah. But in terms of the dollars that get sucked out for our energy bill, if you like, that won't go up if we are more efficient. So it shouldn't affect the type of world that we're used to if our efficiency can match the real increase in the price of the energy that's going to happen. And we're talking about oil and gas here. Now, if you start talking about other energy sources as well then, because that's now becoming such a bigger part of the mix in some countries that we have to start taking that in account. What's the situation with it?

Nate Hagens (00:33:38):

Like what?

Gareth Roberts (00:33:39):

Well, if you look at wind power, for example, it has been put in. Unfortunately, that wind power has been put in using fossil fuel energy, that is our surplus at the moment that we're using. And what we are not really calculating, and I'm generalizing here because some wind installations are more efficient than others. But generally speaking, the net energy output of wind is a lot less than people think. People are thinking of the gross output, but they're not thinking about the energy that went into making the windmill in the first place. And they're certainly not thinking about the energy that's going to be needed to build the replacement windmill in the future. And these numbers are very low, they're even lower than some of these shale wells in some cases. I fear that people are not understanding the relative value of fossil fuels relative to the wind.

Nate Hagens (00:34:35):

That last sentence, I would totally agree with. The rest... I did my PhD thesis on EROI, as you know, and I just think it's a blunt instrument at best. Because you can come up with almost any number you want depending on the boundaries of analysis. I think net energy is one of the most important topics that our culture doesn't understand. We have to spend energy to get energy, and what's left over is what powers society. But then using EROI as a fine tool to analyze things, it's fraught with peril.

Gareth Roberts (00:35:12):

I read six papers trying to come up with this net. It's a great concept to talk about, where between us. But when you start getting into the details and put scientific rigor to it, it's very complex and difficult to do. But I think that people can understand the general idea. We need to put energy into something that then makes energy. And there's a surplus amount of energy. And of course, all through humanity the surplus energy is what's created civilization. So when we started using draft animals, the draft animal contributed to the surplus energy of the society. So they're able to then develop art and other things other than just going out and killing your dinner every day. And then we had fossil fuels come in, we had coal come in, and that added to the surplus of society. And we've had this oil and gas for the last 100 years that have made this tremendous difference. It's the surplus that creates civilization. And so everybody needs to understand that we need to create an energy surplus and then we can use that to create our society.

Nate Hagens (00:36:23):

And here's the other thing that I don't think people understand, is that creating more money doesn't create more energy surplus.

Gareth Roberts (00:36:30):

Not unless it's combustible paper money.

Nate Hagens (00:36:33):

Well, but even that, they're probably a low return on that.

Gareth Roberts (00:36:37):

In some societies, inflation's gotten so bad you could probably use it for-

Nate Hagens (00:36:43):

You can burn it once.

Gareth Roberts (00:36:43):

I don't know if you remember this, but I once did a presentation and joked that the fundamental unit of currency was the BTU, the British thermal unit. Energy is the real currency. Gold coin, you can't do anything with gold. You can't do anything much with diamonds, you can't eat them. It's energy is the unit. And I even-

Nate Hagens (00:37:06):

Well, energy is the currency of life, in nature, that is certainly the case.

Gareth Roberts (00:37:10):

It certainly is.

Nate Hagens (00:37:10):

I want to get to your ideas on a energy societal transition, but I know you went to Oxford and you have relationships there, and you care deeply about education. How can we get the systems, energy, geology more into the lexicon of young people? And it just seems like we're really treading water here on the core things that need to be understood by a population for the future. How can we change that? Or what are your thoughts on education about these issues?

Gareth Roberts (00:37:46):

Well, I think you are doing a grand job with these podcasts, and getting different views together. I think rather than trying to educate the next generation specifically about energy or specifically about anything, I think the general principles need to be stressed, that people need to make up their own minds about things. There needs to be an open discourse about difficult subjects. And if you can teach people that, then they can solve their own problems for themselves. And there'll be different problems 50 years from now, 100 years from now the other generations have to solve.

Nate Hagens (00:38:20):

But how do you teach people to make up their own mind? Is that logics or epistemic, or philosophy, or what?

Gareth Roberts (00:38:27):

Well, I see at the moment a trend towards people being politically correct or correctness, and that's a little dangerous. You see all these western countries all with the same basic philosophy. And what we need, just like we need in society, we say we need diversity. And of course in natural populations you need diversity. We also need diversity of thought, and that's where we need to go. What we should be focusing on is encouraging people to make up their own minds, be able to speak freely on opinions, and not be just shouted down just because somebody doesn't agree with them. This is something, because I went to Oxford and of course we have the Oxford debating societies. And the whole scientific community is based around the idea that we all have opinions and we express them, and thrash these things around until we come up with some real data. I think it's important to understand that we need that, free opinions. And people just can't be shouted down because we don't agree with them. And I see that going on even in the universities, which is shocking really.

Nate Hagens (00:39:39):

No, I agree. I am worried about that. And as far as debating, I would never debate against someone born in England, because they're just the masters. I could never compete.

Gareth Roberts (00:39:53):

No, we grew up on Monty Python, you see? So we know how to argue.

Nate Hagens (00:39:59):

You were friends with all those guys, right?

Gareth Roberts (00:40:01):

Oh, yeah. Well, with Terry Jones particularly, he went to my college, so I met up with him a lot of the time. Some of the others.

Nate Hagens (00:40:08):

I know some of the skits by heart, the cheese shop.

Gareth Roberts (00:40:11):

Yeah, indeed. But the whole point about that was they were at a period of time, and I was lucky enough to be around at that time when the establishment in Britain was okay with you taking pot shots at the establishment. The BBC produced those programs. And they were all about ridiculing silly things in society. That brings us to the topic of humor in this, because I think that humor is one of the ways in which we can correct reality, the perceptions of reality. And if you think about humans, probably humanoids have been around 2 million years or so, and why do we have this sense of humor? You see, there's nothing else that would exist-

Nate Hagens (00:41:00):

For mating, or moving up the mating ladder. I don't know why. I'm just speculating.

Gareth Roberts (00:41:06):

Well, I've got a great sense of humor and that hasn't worked for me. So we'll throw that one out.

Nate Hagens (00:41:12):

You do have a good sense of humor. Since I've known you-

Gareth Roberts (00:41:17):

But let's get serious...

Nate Hagens (00:41:17):

...I don't remember any time you...

Gareth Roberts (00:41:19):

...Why do we have a sense of humor? I don't believe it's mating. But what I think it is, if you imagine a group of humans living together somewhere, and Thag goes up a tree to get a squirrel. Doesn't get the squirrel, falls out of the tree. What's going to happen? The rest of the troop is going to laugh at Thag falling out of the tree. So Thag did a stupid thing. He's not going to catch the squirrel, and he ended up falling out of the tree. What are you going to do to Thag to persuade him that this is not a good idea again?

(00:41:55):

You can go up to him and you can hit him again and tell him not to go climbing trees, or the rest of the community can just laugh at him. Well, it's a non-violent way of correcting stupid behavior. I'm not studied this, but I do believe that there's some real importance to humor. And I think it is a very important mechanism by which we ascertain what is real and what isn't real. And when we have ridiculous behavior by humans, and of course we do that all the time, it's a non-violent way of correcting it. Maybe Monty Python has influenced me too much there.

Nate Hagens (00:42:38):

Some thoughts on that. Number one, this podcast unfortunately is freaking serious. And you know me well enough, you and I crack jokes together all the time. And every time I've been on the phone with you, we laugh. I just don't feel it's appropriate to have a lot of humor on this podcast because the subject matter is so serious. And yet, I agree with you that no matter what happens to human and planetary futures, I hope to laugh and crack jokes and play practical pranks on my brother. That's who I am. But I think the space for humor, given the meta crisis, is diminished. And maybe that's a problem in itself.

(00:43:24):

And then my second reaction was, as events get more chaotic, maybe humor is just a lifeline for people's psyche. The whole bread and circuses in Rome is people were starving and they had to give them entertainment, et cetera, which is the whole Netflix and chill movement now. Is people work, life is tough, and then they watch one of 10 billion Netflix programs at night. I don't know, it's an interesting thing. What is the evolutionary reason for humor?

Gareth Roberts (00:44:00):

Well, certainly during the Second World War in Britain, all of the comedians that I really respect came out of that. War is madness, right? And they treated it that way. And I don't know if Spike Milligan, but he wrote a series of books, Adolf Hitler: My part in his downfall. And then a sequel was, Adolf Hitler: His part in my downfall. But wars is madness, so, yes, there was a certain amount of keeping sanity. But if you look at some of the societies that don't have humor, Nazi Germany was not a place where there was any humor. So is it a symptom or a cure? I don't know which it is, but it's definitely something that's lacking in those. Soviet Russia, probably North Korea, those are not humorous societies.

Nate Hagens (00:45:00):

I am an apolitical person because I believe that we have to... I think there's diversity in thought, like you say. And I think what we face goes beyond Republican or Democrat. But I will just say this one political comment, that President Trump, that was the thing that bothered me the most, is he never laughed or said a joke ever. Ever. And there's just something wrong with that.

Gareth Roberts (00:45:31):

Well, that's right. Well, President Reagan is always well thought of, and he told jokes. He told jokes about the Soviet Union, which are still funny today. But you're right, you're right. It is something that I think we admire in people is a sense of humor. It means that they've got the ability to laugh at themselves, somewhat. Which, you have to that surely. But some of these people, and you named one of them, doesn't have that ability to laugh at himself. It's a dangerous characteristic. Anyway, I think we've gone too much about humor there, but I do think that-

Nate Hagens (00:46:08):

We'll just say that I hope humor depletes less steeply than oil.

Gareth Roberts (00:46:14):

But just going back to more general principles, I know that there's going to be a lot of difficulty with the energy transition, but those difficulties are going to bring around solutions. Probably not by us, but by other people. And I feel quite confident that people will go on and find solutions to all of this stuff. I am not at all thinking that we're in a terminal crisis or anything like that. I'm much more optimistic about the world. And I think the current generation is probably lacking in some tools, but a necessity is the mother of invention. And when crises start coming along, they'll find solutions. So I'm not too concerned about that.

Nate Hagens (00:46:55):

As oil declines, and we peak and decline, but we still have some, plenty of oil, how do you see culture? What does the energy transition look like in the next 30 years to you, the middle of your distribution?

Gareth Roberts (00:47:12):

Well, I might be banging my own drum here, but I'm working right now on using natural gas, burning it in oxygen, which gives you two byproducts, which is CO2 and water. Because the water condenses out and it's pure water. And then the CO2 is sequestered. It's something that I know about because of my background in geology, we can put that in the ground safely. As we did for many years, we put it into old oil reservoirs. We can still do that today as well. And the beauty about having natural gas is that it can be switched on and off very quickly. So if you can imagine you do have renewables, you have wind, and you need backup for that. Your natural gas, as we know in Europe today, is the counterpoint to renewables. Well now if you can quest to the CO2 that comes from burning that natural gas, then you have something that everybody should be happy with.

(00:48:07):

So as long as we have natural gas, we have that ability. Now, longer term, we're going on for another 100 years or so, we absolutely need some nuclear program. I doubt whether fusion is going to work, but we should still work as hard as we can on that. But there are fission reactions that can be put together. We've been using 1960s technology for a long time here, let's get with it. And unfortunately, the amount of money that is been spent on real nuclear research is tiny compared with all the money that we're spending on everything else. So that needs to be changed. And they're very safe cycles that can be created. We're using the simplest and most inefficient uranium cycle at the moment, and we create plutonium with it. We don't want to create plutonium with these excess, that's just not a good thing.

(00:49:01):

Let's get some reactions put together that don't do that. Let's make them small enough so we can drop them into Bangladesh, give them a source of power. They're not going to need anywhere near the amount of power that we think society needs today, but they need some. And let's do that. But the other thing I would say is that these arbitrary time scales for net-zero, not possible in my view. And actually damaging. Because what they're doing is a lot of people who know a little bit about this stuff realize that it's not possible to go net-zero by 2030 or 2050, and therefore they ignore it. It's not helpful to put out arbitrary timescales when you don't really understand what's involved. You mentioned earlier the electrification required to replace gasoline as a transportation fuel.

(00:49:55):

It is a massive, massive undertaking. It's not possible. There isn't enough copper, there's not enough batteries. And these things are not environmentally friendly to begin with. We've got to start looking more at all environmental issues, not just CO2 emissions. I'm more of a fundamental environmentalist when it comes to habitat preservation, basic efficiency that we're talking. We live in a disposable society, and all these plastic... Oh look, I've got one here, a plastic water bottle. These are sinful things really. And those we can do something about. Whereas, sometimes we can't always do something about CO2, sometimes we need to have a fire.

Nate Hagens (00:50:43):

What I'm hearing is, oil is going to peak. There will still be a large demand for oil because of its quality, but the gross amount is going to decline relatively soon. And we're going to have to expand natural gas. We can, with potential technologies being worked on, burn the natural gas and have water as a byproduct, and CO2 as a byproduct, which can be then sequestered underground. And some compliment of yet to come and existing nuclear technologies, which will smooth future decades of total societal energy availability.

Gareth Roberts (00:51:26):

Yep, you've got it. Those are my four points that I wanted to make.

Nate Hagens (00:51:34):

Just a quick clarification. Can you actually permanently sequester CO2 in an old oil field? How does that actually work? Could you walk us through the mechanics of that?

Gareth Roberts (00:51:47):

Well, the oil is usually several million years old in that reservoir. So, yes, you can. And now the problem comes when you're sequestering in something that was not an oil and gas reservoir because you might not have a trap. So there's issues behind making sure that it doesn't come right back out again. And that's just more expensive. Carbon capture and storage is best done in the right geological provinces, it's not always going to be convenient to do it. So where you live, for example, you're on what we call the Canadian Shield rocks, and there's no reservoirs down there that we can put the CO2 into. But then again, places like the US Gulf Coast are massive industrial areas, lots of emissions, so we need to tackle the low hanging fruit first.

Nate Hagens (00:52:41):

How can we even conceptually have... We've got a Department of Energy, and Jennifer Granholm, and they're playing Whac-A-Mole it seems like with the strategic petroleum reserve and all the things now. How could we have some systemic view of the next 30 or 50 years to even come to some blend of renewables and nuclear and depleting fossil fuels to power society? What governance structure would enable such a thing even to work on it? Because right now we've outsourced the governance to the market. And the prices tell us, okay, here's the signal. But there is no overriding strategy on how the pieces fit together.

Gareth Roberts (00:53:24):

No, and it's been badly done in the past. The way that the renewables work in say the Texas market or even in the UK market, is that they're basically given a minimum subsidy to run. Which means a lot of times they can actually get paid negatively. They pay to have their power put in because they're getting such a subsidy, but they don't have a ceiling on them. Those happened in the UK is that when the marginal fuel, natural gas has gone up in price, all of the electricity goes up in price. And so windfall literally for the wind farms. And the same structure exists in Texas. So when the wind blows, it puts everybody else out of business. And then when the wind doesn't blow, there's no backup capacity.

Nate Hagens (00:54:13):

Yeah, it's a problem.

Gareth Roberts (00:54:15):

Well, see, the idea was that they could somehow have a free market for power. And I'm a free market guy for most things, but when it comes to energy, this free market thing probably doesn't work. The states that do the best are the ones that still got the old-fashioned system where they have the public utility commission and they basically have one single entity that's designing the system, and they can then design it to work. But when you have a bunch of disparate groups all throwing this energy into the grid, and then all of a sudden you have a spectacular failure. It has to be redone, I think.

Nate Hagens (00:54:54):

Do you think because energy is so central to human existence and human futures, that eventually it should be a national good instead of dictated by the market? You tell me, something like 85% of the world's oil and gas reserves are owned by national oil companies, not by Exxon or Shell.

Gareth Roberts (00:55:19):

Yeah. Yeah, that's true.

Nate Hagens (00:55:20):

And let me ask you this, if there was an overarching entity that was overseeing all this, wouldn't we get more oil out of the shale fields because there wouldn't be cannibalization of one company drilling into another company's field? Wouldn't it be more efficient if there was like a grand plan?

Gareth Roberts (00:55:41):

No, I don't think so, not when it comes to the shale and development. And I think as far as allocation of the asset, the energy once it's been created, is different from actually creating the energy. What we need is private enterprise and human efficiency to come up with the energy, and may be sold into a central market. But then what we're talking about is allocating the energy to where it needs to go. And I think that's going to happen. It's not really just whether I think it's a good or bad thing, it's inevitable that governments move over to allocate that. They're already doing it in certain ways, but I think it's just inevitable they do. Because it's such a vital part of human existence, this energy, whether it's-

Nate Hagens (00:56:30):

You and I know that. Do governments really know that?

Gareth Roberts (00:56:34):

No, otherwise they'd be doing it already. Imagine during the wars when they were rationing gasoline, that's the thing that you're probably looking at. Let's say oil went to $1,000 a barrel, and the government would say, "That's just not acceptable. We're not doing that. What we're going to do is going to use less gasoline, and the way we're going to do it is we're going to ration it to you." So that's the mechanism that you'll see.

Nate Hagens (00:57:02):

And then you will automatically get massive carpooling and people taking one trip to the town to get provisions a week instead of one a day. And all kinds of behavior changes from that.

Gareth Roberts (00:57:15):

Well, yes. When I was a kid we had a ration book, and we didn't have a lot of fresh food.

Nate Hagens (00:57:26):

How did that work? Can you give a story about that just for a minute or two?

Gareth Roberts (00:57:29):

Well, I was a little kid, so I didn't actually go to the store myself with the ration book. But we didn't have any candy, there's no sugar around. The powdered eggs came from the US. We had Spam, cans of Spam. I still like Spam. And of course there's a Monty Python joke about Spam. Because we had Spam with everything, and that's the joke. And all of a sudden Spam now has become a name for all the junk that's on the computer, which is why it doesn't work that well when I'm talking to you. And we didn't have proper coffee, we had chicory coffee, which is a liquid. And they still use that in New Orleans, so I do like New Orleans coffee because they have chicory in it. But we didn't have much. But you can survive on so much less. And I'm actually trying to do that a little bit myself now, I've gotten rid of the big house. But I'm astonished at how much waste a single person produces, it is embarrassing and-

Nate Hagens (00:58:28):

It is embarrassing.

Gareth Roberts (00:58:32):

I don't have the answer to how the next generation is going to survive. But they will work it out. They do. People are very adept if you let them.

Nate Hagens (00:58:43):

We've talked about many things. I may have you back next year to take a deep dive on some of the potential technologies of turning natural gas into both CO2 and water, et cetera. But if you don't mind, I will ask you some personal questions that I ask all my guests at the end of the interview. You and I have known each other going on 15 years. Do you have any personal advice to people watching or listening to this at this time with global anxiety about the future? You've mentioned a few things, but do you have anything further on that?

Gareth Roberts (00:59:22):

Well, I think that people just need to educate themselves better, and form their own opinions a little bit more, rather than just going along with the general crowd. And I do think we need more diverse opinions to solve these difficult problems. I would say, education is important. But as I said earlier, it's not the education on specific subjects, it's the understanding that you can make choices, and you need to make your own choices. That's really the message that I would give. And I would give that to my kids, and I think probably I have done already. And that's the most important thing for the future of society, is to maintain diverse thought processes. And Bertrand Russell said, "Stick to facts." Get the facts. Don't spend too much time on human speculation, get into the facts. He was very adamant about that.

Nate Hagens (01:00:25):

I am adamant about that too. But our current social media commons makes it difficult to just get the facts at times. There's the philosophy and the ethics that you're talking about, but there's also the technology is battling your objective that you just suggested.

Gareth Roberts (01:00:46):

I thought that too, thinking about... It seems like we're just swamped with misinformation or just random information. But you know what I think it is, Nate? Is I think that this was always the case in human history, but what we've done is we speeded it up 10,000 times. So if you go through the Middle Ages, there were various memes going around that would take 10, 20 years. And now we're just going, whoosh, and it's just all hitting at once. I'm trying to think that we are not really that different than people that lived 1,000 years ago, or even 10,000 years ago. And I think it's just that our technology has just speeded up the process to us.

(01:01:31):

And fundamentally, as human beings, we are not any different at all. We got to recognize that. We think that we are more superior, we think that we have better views than they did a century ago. But then the people that live 100 years from now are going to look back on our values and think that we were horrible people as well. You can't just keep assessing history with the values of today that we do at the moment. You got to recognize that people had different views back then and that was necessary for their survival.

Nate Hagens (01:02:07):

What do you care most about in the world, Gareth?

Gareth Roberts (01:02:09):

Nothing, really. Nothing. Nothing. I'm very happy. I've got to 70 years old, and now I'm playing, as I say, with the house's money. Personally, I don't have any problems. And I do have this optimism about the future for society that I think is sadly lacking. We seem to concentrate too much on the negatives, and it's easy to do that, there's a lot of negatives. Human history is full of all these negative things, and yet still we've managed to build something today. Look at what we've built. I don't believe that we are harming the earth, I think we're part of the earth. I think we're the children of the earth, and we are entitled to do things.

(01:02:58):

What we've got to be careful is we don't do things that harm us. We destroy the environment, we're harming us. But I don't think that we should apologize for being here on the earth. I think we're really how matter has evolved, and now it's evolved into something that's actually can recognize itself. So I'm optimistic. I wouldn't make another caution as well, because we're interacting with science all the time. But remember that scientists are wrong 95% of the time. But you got to realize that a scientist is telling you this.

Nate Hagens (01:03:35):

But there's certain things we're not wrong about that, as children of the earth, just to push back a little, we know that our species is taking 35 to 40% of the net primary productivity, directing it towards our one species, out of maybe 10 million species. And your field, we're taking ancient productivity and

adding it to the current system as well. So we are shrinking out nature. You mentioned habitat before. So the other species are taking it on the chin by us doing our normal bidding. Yes?

Gareth Roberts (01:04:13):

Yes, yes. But when we are gone, they will be... If you got rid of humans today, the earth would be a different place. 1,000 years from now we, there'd be no trace of us and it would go on. And what's going to happen a million years from now? We have got a problem. We've got 8 billion people on the planet, you can't keep growing at that pace. But as I say, I've tried to predict what the future would be. And it's a waste of time. You can't. I won't worry about it. Basically population dynamics or so, it's like a giant ameba moving forward and it moves in different directions and-

Nate Hagens (01:04:53):

Well, it moves in one direction. It moves forward eating up energy until it runs out of energy.

Gareth Roberts (01:04:59):

Well, I was talking about the way that societies interact and how people actually evolve. The thoughts and so on like that. Yeah, we are using too much of the planet at the moment, there's no doubt about that. But it's not really the planet I'm worried about, it's the humans. But let's just state clear, the biggest threat to humans is other humans. That's always been the case throughout history, and will continue to be the problem. We really don't need to focus on this inorganic side of the world, we need to look very carefully at the people around us and what they're doing. And we're seeing an example of that right now, aren't we, in Ukraine?

Nate Hagens (01:05:45):

Yeah, I'm very worried about that. A couple more questions, Gareth. What, out of all the issues in the world, what is the single biggest thing that you are worried about in the next 10 years?

Gareth Roberts (01:05:57):

I think it's energy. I think energy is going to come to the fore. I say I'm not too worried about it, what I do worry about is that other people don't have that information and they're going to make wrong decisions. And they're not prepared for it. And they weren't prepared for the energy crisis in Europe, but that was not caused by Putin, that was taken advantage of by Putin. Right?

Nate Hagens (01:06:23):

Yeah, I agree with that.

Gareth Roberts (01:06:25):

But the basic problem was already there, and that's what happens when you don't understand the energy situation. And it's going to become more and more apparent, and it's going to more of a problem. We're nowhere near the worst that's going to come.

Nate Hagens (01:06:42):

Do you have any stories or experiences in the past year in your life that are hopeful or give you hope about the future?

Gareth Roberts (01:06:51):

Well, I've never been distressed about the future. So anything specific out there, I do think that humans have that ability to adapt. What made us successful was our ability to adapt to different environments. It wasn't our ability to adapt the environment to us. We've adapted. So we need to go back a bit to basics and say, all right, we need to... But I'm confident about that. I don't have any particular stories that I need to cheer me up, other than the fact that I made it to 70 years old. I think that's probably a decent accomplishment.

Nate Hagens (01:07:29):

Congratulations. I don't know why that is, but you're exactly 70. I know 15 people in my core network that are not 69 or 71, they are all 70 right now. It's a strange thing. If you were benevolent dictator, oh my gosh, it's hard to imagine. And there was no personal recourse to your decisions. What is one thing that you, Gareth Roberts, would do to improve human planetary futures?

Gareth Roberts (01:07:55):

All right. I think it would be the focus on nuclear. I would start that process, I would get going on that one. And again, you can't just do it by diktat. You'd have to say, okay, we're going to try different things. It's important to have this diversity of approach and let's find out what works. You have to look at this empirically, you have to try what works.

Nate Hagens (01:08:21):

But how would that actually mechanically work? If you were benevolent dictator and you said, we need to expand what we're doing in nuclear, what would that look like?

Gareth Roberts (01:08:29):

Well, you'd have-

Nate Hagens (01:08:30):

Like subsidies?

Gareth Roberts (01:08:31):

No, no, I think governments have to just do it. I think governments have to pay for it. But you could have a competition amongst these different groups. It takes real money to do that. And you're looking at 20, 30 years of expenditure, so it's a massive amount of society's current energy.

Nate Hagens (01:08:53):

Surplus.

Gareth Roberts (01:08:53):

Surplus to be taken away and put into that. So what I worry about-

Nate Hagens (01:08:58):

That's the problem I have with all of these renewable energy or alternative energy scenarios. Is for us to invest that amount of energy surplus, we have to take it away from the shopping centers and hospitals and universities and NASCARs and Disneylands. Or somewhere in society that's using it now.

Gareth Roberts (01:09:16):

Well, if you imagine there's a million others, and we're sitting in a big field and we've all got shovels. And we decide that nuclear now is the best option, how do you build that? You can't. You only build it because you have a surplus of energy. And that surplus of energy came from fossil fuels. Even the power that we are getting from windmills and solar is still coming today from fossil fuels, because we haven't replaced their energy with their own energy yet. That's the problem, is we are going to use up this dowry, if you like, of energy that we've been blessed with on this earth. Can't even imagine. The chances of this being able to just drill wells in the ground and get this millions of years of solar radiation to us.

Nate Hagens (01:10:08):

It's a gift that we've squandered.

Gareth Roberts (01:10:10):

Right. And so we need to use what's left to that gift to build something that will last 100 years, and then produce enough energy to build another one after that, and another one. These things need to be able to reproduce themselves, this energy source. And there's plenty of energy in fission. There's lots of energy in fission. And that's what I would do if I was a benevolent dictator, I would start on that path. There are people out there that know how to do all this stuff. And this is another area where society has decided that it's really, we don't want nuclear. We're scared of nuclear. But the facts on nuclear safety are very good indeed. It's extremely safe. And there's always some risk in anything that we do, but we need to take those risks when it comes to this.

Nate Hagens (01:11:02):

Thank you, Gareth, for spending time with me today. Do you have any closing thoughts that you'd like to share with people listening?

Gareth Roberts (01:11:09):

No, I want to get on my bike ride. And I'm sure everybody else has got their own bike ride they want to go on.

Nate Hagens (01:11:16):

Yeah. Well metaphorically, I'm going to try to do snowshoes. Thank you for your lifetime of work on energy and your humor and your curiosity. To be continued, my friend.

Gareth Roberts (01:11:30):

All right. Thank you, Nate. Keep up the good work. Let's get some more opinions out there.

Nate Hagens (01:11:35):

Thanks, Gareth. Thanks. If you enjoyed or learned from this episode of the Great Simplification, please subscribe to us on your favorite podcast platform and visit thegreatsimplification.com for more information on future releases.